REMARKS

Claims 5-7, 15-19, 23, 29-31 and 35-54 are pending in this application, with claims 5, 6, 15, 16, 35, 36, 39 and 40 being independent. Claims 5, 6, 15, 16, 35, 36, 39 and 40 have been amended. Specifically, claims 5, 6, 35, 36, 39 and 40 have been amended for clarity, and claims 15 and 16 have been amended to recite that the element capable of promoting crystallization of silicon is introduced into the first amorphous semiconductor film including silicon and germanium and the second amorphous semiconductor film including silicon after forming the second film, as shown in the application at, for example, page 28, line 24 to page 29, line 1. Claims 47-54 have been added and recite the additional step of "patterning the first amorphous semiconductor film and the second amorphous semiconductor film before crystallizing each of the first amorphous semiconductor film and the second amorphous semiconductor film." Support for new claims 47-54 may be found in the application at least at page 69, line 6 to page 70, line 5. No new matter has been introduced.

Applicants wish to thank Examiner Matthew Song for the interview with applicants' representatives on October 18, 2005, the substance of which is incorporated in these remarks.

Independent claims 5, 6, 35, 36, 39 and 40, along with their dependent claims 7, 23, 37, 38, and 41, have been rejected as being unpatentable over Shimizu (U.S. Patent No. 5,753,541) in view of Noguchi (JP 04-168769) and over Noguchi in view of Shimizu. Applicants respectfully traverse these rejections.

Independent claims 5, 6 and 39, as amended, each recite a method of manufacturing a semiconductor device including "forming a first amorphous semiconductor film comprising silicon and germanium on the insulating surface/film wherein a concentration of the germanium is within a range of *0.1 atom% to 10 atom%*" (emphasis added), "forming a second amorphous semiconductor film *on and in contact* with the first amorphous semiconductor film" (emphasis added), and "crystallizing each of the first and second amorphous semiconductor films by irradiating with an excimer *laser light*." (emphasis added). Independent claims 35, 36 and 40, as amended, each recite a method of manufacturing a semiconductor device including "forming a first amorphous semiconductor film comprising silicon and germanium on the insulating

surface/film wherein a concentration of the germanium is within a range of *0.1 atom% to 10 atom%*" (emphasis added), "forming a second amorphous semiconductor film *on and in contact* with the first amorphous semiconductor film" (emphasis added), and "crystallizing each of the first and second amorphous semiconductor films by irradiating with a *laser light*." (emphasis added). Applicants request reconsideration and withdrawal of the rejections of claims 5, 6, 35, 36, 39 and 40, and their dependent claims, because neither Shimizu, Noguchi, nor any proper combination of the two describes or suggests forming a first amorphous film of silicon and germanium with a concentration of the germanium within a range of 0.1 atom% to 10 atom%, forming a second amorphous semiconductor film on and in contact with the first film, and crystallizing the first and second amorphous films by irradiating with laser light.

Shimizu describes a method of fabricating a thin field effect transistor on a glass substrate 1 including the steps of forming a silicon nitride layer 1a on the glass substrate, an amorphous silicon layer 5a on the silicon nitride layer 1a, and an amorphous germanium layer 6a on the amorphous silicon layer 5a (Fig. 1, col. 5, lines 18-32). Shimizu describes using this structure to achieve a lower crystallization temperature for the silicon. In particular, Shimizu describes that the germanium layer has a lower melting point than the silicon layer and, therefore, crystallizes at a lower temperature. At the interface between the germanium layer and the silicon layer, the crystallization of the silicon is lowered because of the presence of a eutectic point of silicon-germanium. Col. 3, line 64 to col. 4, line 2. Shimizu describes the crystallization process progressing from the germanium layer to the silicon layer and describes using heat treatment for the melting and recrystallization. Col. 4, lines 2-10. Shimizu additionally states that, because the germanium layer efficiently absorbs ultraviolet rays, even laser light may be used for the melting and recrystallization: "Since the germanium absorbs ultraviolet rays efficiently, even by irradiating light from an ultraviolet laser[sic], a temperature rise occurs so that recrystallization of the amorphous silicon layer can take place." Col. 4, lines 10-14.

Shimizu suffers from two deficiencies with respect to claim 5, 6, 35, 36, 39 and 40. First, the amorphous germanium layer 6a, which the Examiner equates to the recited first amorphous semiconductor film, does not include silicon and, accordingly, is not a "silicon and germanium" film as claimed. Second, the step of forming the amorphous germanium layer 6a occurs after the step of forming the amorphous silicon layer 5a, which the Examiner equates to the recited second

amorphous semiconductor film. Accordingly, Shimizu also fails to describe or suggest forming a second amorphous semiconductor film on and in contact with the first amorphous silicon and germanium semiconductor film.

The Examiner relies upon Noguchi to cure the deficiency of Shimizu with respect to Shimizu's lack of a "silicon and germanium" film, stating that "a lower germanium concentration [as the Examiner contends is taught by Noguchi] would be desirable to limit the amount of impurities, which can diffuse through the device during high temperature processes." (bracket information inserted by applicants). The Examiner also attempts to cure the deficiency of Shimizu with respect to the order of the manufacturing process steps by asserting that "It would have been obvious to a person of ordinary skill in the art to modify Shimizu by using the sequentially laminated amorphous SiGe and amorphous Si layers taught by Noguchi et al to lower the solid growth temperature of the amorphous Si layer, which is desirable, as taught by Shimizu".

Applicants submit that a person of ordinary skill in the art would not have been motivated to combine the teachings of Shimizu and Noguchi in the manner suggested by the Examiner. First, a person of ordinary skill in the art would not have been motivated to decrease the germanium concentration of the germanium layer of Shimizu, as suggested by the Examiner. Shimizu specifically teaches away from such a modification by stating that the ability of the germanium layer to efficiently absorb laser light is important in enabling the crystallization process to occur at a lower temperature when using laser light (as described above). A decrease in the concentration of germanium from 100 atom% germanium to the claimed 0.1 atom% to 10 atom% germanium would, therefore, drastically reduce the absorption of laser light and go against Shimizu's teachings.

Moreover, a person of ordinary skill in the art would not have been motivated to change the order of the manufacturing steps as suggested by the Examiner because, as stated above, Shimizu describes the crystallization process progressing from the germanium layer to the silicon layer, and, therefore, Shimizu describes that the germanium layer since it is the absorber for the impinging UV rays, is advantageously positioned on top of the silicon layer to maximize the temperature rise of the silicon layer. To change the order, therefore, would go against the

teachings of Shimizu, as such a change would result in a lower temperature rise of the silicon when using laser annealing.

The Examiner also has rejected claims 5, 6, 35, 36, 39 and 40, and their dependent claims as being unpatentable over Noguchi in view of Shimizu. Noguchi describes a method of manufacturing a photovoltaic element that includes forming a multi-layer structure by first forming an amorphous SiGe or amorphous Ge layer 2, which the Examiner equates to the recited first amorphous semiconductor film, on a substrate 1 and then forming an amorphous Si layer 3, which the Examiner equates to the recited second amorphous semiconductor film. Noguchi describes crystallizing the multi-layer structure through heat treatment, rather than through use of a laser light.

The Examiner relies on Shimizu to cure the deficiency of Noguchi with respect to use of a laser light to crystallize the recited first and second amorphous semiconductor films, stating:

> Shimizu also teaches the application of heat or light to promote recrystallization of amorphous germanium will result in progress of recrystallization of the amorphous silicon layer at a lower temperature than that by conventional methods and laser annealing can be replaced with heating to a temperature greater than 600°C (col 4, ln 64 to col 4, ln 20 and col 6, ln 20-35), this is a teaching that the application of heat or light are equivalent methods of recrystallization of amorphous SiGe and Si layers.
>
> It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Noguchi et al's heat treatment by using an excimer laser annealing, as taught by Shimizu [sic], because substitution of known equivalents for the same purpose is held to be obvious (MPEP 2144.06)

(Office Action of February 9, 2005, page 6, lines 11-20).

Applicants disagree with the Examiner's assertion that Shimizu teaches that heat treatment and laser annealing are known equivalents. While Shimizu refers to crystallization of Shimizu's amorphous Ge on amorphous Si structure as being possible through application of heat or light, Shimizu specifically distinguishes between heat treatment and laser annealing by stating that laser annealing may be used as an effective alternative to heat treatment to achieve the beneficial lower temperature crystallization of the silicon layer because of the efficient absorption of UV rays provided by the germanium layer of Shimizu's device. Heat treatment, in contrast, does not require such an absorption layer, and accordingly, is not equivalent to laser annealing, contrary to the Examiner's contention. Moreover, given the lower concentration of germanium asserted by the Examiner as being taught by Noguchi and the order of manufacturing steps taught by Noguchi resulting in the silicon layer being placed on top of the

silicon/Germanium layer, a person of ordinary skill in the art would not have been motivated by Shimizu to replace Noguchi's heat treatment with laser annealing because, for the reasons described previously, the order of the layers and the lower concentration of germanium would not achieve the desired absorption of UV rays and higher temperature rise of the silicon for melting and recrystallization.

For at least these reasons, applicants request reconsideration and withdrawal of the rejections of claims 5, 6, 35, 36, 39 and 40, along with their dependent claims 7, 23, 37, 38, and 41.

Claims 42 and 45, which depend from claims 39 and 40, respectively, have been rejected as being unpatentable over Shimizu in view of Noguchi and Maekawa (U.S. Patent No. 6,066,547) or over Noguchi in view of Shimizu and Maekawa. Maekawa does not remedy the failure of Shimizu and Noguchi to describe or suggest the subject matter of claims 39 and 40. Accordingly, applicants request reconsideration and withdrawal of the rejection of claims 42 and 45.

Independent claims 15 and 16 have been rejected as being unpatentable over Shimizu in view of Noguchi, over Noguchi in view of Shimizu, over Noguchi in view of Applicant's Admitted Prior Art (AAPA), over Shimizu in view of Noguchi and AAPA, and over Noguchi in view of Shimizu and AAPA. Claims 17 and 29, which depend from claims 15 and 16, respectively, have been rejected as being unpatentable over Shimizu in view of Noguchi and AAPA and over Noguchi in view of Shimizu and AAPA.

Claims 15 and 16, as amended, each recite a method of manufacturing a semiconductor device including "forming a first amorphous semiconductor film ... ," "forming a second amorphous semiconductor film including silicon on the first amorphous semiconductor film," and "introducing an element capable of promoting crystallization of silicon into the first amorphous semiconductor film *and* the second amorphous semiconductor film *after forming the second amorphous semiconductor film*" (emphasis added). Applicants request reconsideration and withdrawal of the rejection of claims 15 and 16, and their dependent claims, because neither Noguchi, Shimizu, AAPA, nor any proper combination of the three describes or suggests introducing the recited crystallization promoting element into both the first and second semiconductor films after forming the second amorphous semiconductor film.

As stated previously, Noguchi describes a method of manufacturing a photovoltaic element that includes forming a multi-layer structure by first forming an amorphous SiGe or amorphous Ge layer 2, which the Examiner equates to the first amorphous semiconductor film, and then forming an amorphous Si layer 3, which the Examiner equates to the second amorphous semiconductor film. Accordingly, while Noguchi describes having Germanium, which the Examiner equates to the element capable of promoting crystallization of silicon, in one of two stacked layers, it does not describe or suggest introducing an element capable of promoting crystallization of silicon into both the SiGe/Ge layer 2 and the Si layer 3 after forming the Si layer 3.

As stated previously, Shimizu describes a method of manufacturing a thin field effect transistor. Shimizu describes a field effect transistor having a Ge layer 6a, which the Examiner equates to the recited first amorphous semiconductor film, formed on a silicon layer 5a, which the Examiner equates to the recited second amorphous semiconductor film. Like Noguchi, Shimizu also does not describe or suggest introduction of an element capable of promoting crystallization of silicon into both the recited first and second amorphous semiconductor films after forming the second amorphous semiconductor film. Moreover, as described above, a person of ordinary skill in the art would not have been motivated to combine Shimizu and Noguchi in the manner suggested by the Examiner.

AAPA describes introducing a metal element which promotes crystallization of silicon into an amorphous silicon film and then using heat treatment to crystallize the silicon film. While AAPA does describe introducing a metal element that promotes crystallization into an amorphous silicon film, it does not describe or suggest introducing such an element into each of two stacked films, such as the recited first and second amorphous films, after forming the second of the two films.

For at least these reasons, applicants request reconsideration and withdrawal of the rejections of claims 15 and 16, and their dependent claims 17 and 29.

Claims 18 and 30, which depend from claims 15 and 16, respectively, have been rejected as being unpatentable over Shimizu in view of Noguchi, AAPA and Maekawa, Noguchi in view of AAPA, Shimizu and Maekawa. Maekawa does not remedy the failure of Shimizu, Noguchi,

and AAPA to describe or suggest the subject matter of claims 15 and 16. Accordingly, applicants request reconsideration and withdrawal of the rejection of claims 18 and 30.

Claims 19 and 31, which depend from claims 15 and 16, respectively, have been rejected as being unpatentable over Shimizu in view of Noguchi and Zhang (U.S. Patent No. 5,578,520), over Shimizu in view of Noguchi, AAPA and Zhang, over Noguchi in view of Shimizu, AAPA and Zhang, and over Noguchi in view of Shimizu and Zhang. Zhang does not remedy the failure of Shimizu, Noguchi, and AAPA to describe or suggest the subject matter of claims 15 and 16. Accordingly, for at least the reasons described above, applicants request reconsideration and withdrawal of the rejection of claims 19 and 31.

Independent claims 5, 6, 15, 16, 35, 36, 39 and 40, along with their dependent claims 7, 19, 31, 37, 38 and 41, have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1, 7, 50, 51, 59, 60, and 66 of U.S. Patent No. 6,482,684 ("the '684 patent") in view of Noguchi and AAPA.

The Examiner acknowledges that claims 1, 7, 50, 51, 59, 60, and 66 of the '684 patent do not recite the limitation "forming a first amorphous semiconductor film comprising silicon and germanium on the insulating surface/film wherein *a concentration of the germanium is within a range of 0.1 atom% to 10 atom%*" (emphasis added), as recited in claims 5, 6, 15, 16, 35, 36, 39, and 40. The Examiner, however, relies upon the teachings of Noguchi to cure this deficiency, asserting:

> Noguchi et al actually does teach the claimed concentration because Noguchi teaches the entire range of concentrations for pure silicon to pure germanium, note Figure 2. Noguchi merely teaches it is preferable to have a higher concentration to lower the heat treatment temperature. The heat treatment temperature can be lowered as desired by Noguchi with a low germanium concentration by incorporating a metal element, which promotes crystallization, note instant claim 15 and Applicant's Admitted Prior Art.

(Office Action page 15, lines 2-7).

The law of obviousness is not whether something could be modified, but whether there is a suggestion or motivation in the references for the proposed modification. "The fact that a prior art device could be modified so as to produce the claimed device is not a basis for an obviousness rejection unless the prior art suggests the desirability of such a modification." *In re Gordon*, 733 F.2d 900 (Fed. Cir. 1984). In this case, the Examiner is suggesting that Noguchi would have led someone skilled in the art to modify the claims of the '684 patent to recite a

silicon and germanium layer having germanium concentration within a specified low concentration range of 0.1atom% to 10atom%. Even if Noguchi discloses all ranges of germanium from 0 to 100 percent as suggested by the Examiner, this alone would not have led a person of ordinary skill in the art to modify the claims of the '684 patent to recite specified germanium concentration range. Moreover, Noguchi does not teach or suggest the parameters, variables, and/or attributes that, when optimized through "routine experimentation," as suggested by the Examiner, would have led a person of ordinary skill in the art to the specified germanium concentration range.

On the contrary, as stated in the response to the Office Action of February 9, 2005, Noguchi explicitly teaches away from using a germanium concentration within the range 0.1 atom% and 10 atom%. In particular, as shown in the full translation submitted in the IDS of November 22, 2004, Noguchi states that conventional methods of forming polycrystalline silicon from amorphous silicon on a substrate require a solid growth temperature of 500°C or more. According to Naguchi, such a high temperature is problematic because it makes the use of low cost glass substrates difficult. See Noguchi Translation, page 2, lines 15-18. Noguchi solves this problem by introducing germanium into the amorphous silicon to lower the solid growth temperature to below 500°C. Accordingly, Noguchi does not contemplate and, in fact, teaches away from using the recited low germanium concentration since, as shown in Fig. 2, such a concentration would result in a solid growth temperature well above 500°C, rendering use of a glass substrate once again problematic. Indeed, Noguchi's focus is clearly on using high concentrations of Germanium of around 80 atom% or more to decrease the solid growth temperature to 400°C or less. See Noguchi Translation, page 3, lines 6-11 and page 4, lines 5-8 and 13-22. Accordingly, Noguchi does not describe or suggest forming the recited film having silicon and germanium wherein the concentration of the germanium is within the relatively low range of 0.1 atom% to 10 atom%. AAPA does not remedy this failure to describe or suggest this feature.

Applicants do not acquiesce to the characterizations of the art. For brevity and to advance prosecution, however, applicants have not addressed all characterizations of the art, but reserve the right to do so in further prosecution of this or a subsequent application.

Applicants submit that all claims are in condition for allowance.

Enclosed is a $450 check for the Petition for Extension of Time fee. Please apply any other charges or credits to deposit account 06-1050.

Respectfully submitted,

Date: 12/27/05

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